Why Should We Test Tape?

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Sometimes we take a lot for granted. For example, when we press the RECORD button at the beginning of a session, we expect to create a recording that will faithfully capture our musical event for later processing. To guarantee success, we prepared for this moment by carefully testing and aligning the various components of the signal chain. The microphones are placed and equalized, console and monitoring functions preset and checked with a listening test during rehearsal, and the tape recorder biased and equalized for the type of tape being used. Now the moment of truth is at hand as we switch the monitors to tape playback to check our results. We stare in horror that the 40 union musicians performing in the studio as the playback crackles and pops behind a distorted image of our source material .

What went wrong? We did everything we could, didn't we? Well, almost - but not quite everything.

The equipment you are using is tried and true - you have used it a hundred times before - EXCEPT FOR THE ROLL OF TAPE! Every session gets a fresh roll of tape - an untested roll of tape which represents a random sample from the tape manufacturer's output of hundreds of miles of tape a week. Did the manufacturer test this particular roll thoroughly? No, he cannot afford either the time or the equipment necessary to test every roll completely. Did you test the roll thoroughly? Let us review what you did and did not do

You started your pre-session alignment by cleaning the heads and running the alignment tape. Next, you put on you battle-scarred shop tape to set bias, equalization and record levels. Third, you put on the new roll of tape and recorded reference tones at 1 kHz, 10 kHz and 100 Hz and possibly a Dolby tone.

Consider some of the pitfalls that could trap you in the above procedures:

1. The client is bringing his own tape stock. By the time you get his roll of tape, he is already making use of the control room. You try to keep out of his way while you check his tape and put on tones. As a result, you never CRITICALLY LISTEN to the playback from the tape at full level in the monitors to check for tape- induced flaws.

2. A 'last minute' alignment due to a crowded schedule or the need to diagnose and repair a fault discovered during the checkout. You revert to the 'inconspicuous mode' described in Pitfall #1 when the client arrives.

3. Yyou have all the time in the world, but never critically listen to the tape playback during testing. After al, who wants to suffer through 24 tracks of sinewave tones time after time?

4. The client changes his mind and wants a different tape type, track format or an extra machine. PANIC TIME!

This discussion points out a critical fundamental problem. We need a simple but reliable method to test tape. We will begin our search for such a procedure by looking at the tape manufacturing process used by the tape manufacturers. Each step has a distinct set of problems and symptoms.

First, the basic recipe of approximately a dozen ingredients that form the oxide mixture must be correct. Each ingredient must be pure and must be measured correctly. Errors in mixing and experimental 'formula modifications' often lead to non-durable oxides that shed debris onto the guides and heads.

Second, the mixing of the ingredients must be thorough but not excessive. Inadequate mixing leads to high modulation noise and high background noise. Excessive mixing reduces noise, but also increases print-through.

Third, the coating process must produce a uniform coating across the width and length of the tape. The coating is applied to 'jumbo' rolls ranging from 18 to 36 inches in width. To fully monitor the entire width of one of these rolls, the tape manufacturer would need the equivalent of over 400 channels of record/reproduce circuits!

Fourth, the tape is baked to remove solvents by passing the coated web through a multi-zone oven. Poor temperature control can lead to brittle or soft oxides.

Fifth, the jumbo roll is run through heated rollers that densify the oxide to increase output and high-frequency response. This 'calendering' step is a major factor in determining the modulation noise content of the finished tape.

Sixth, the tape is slit to the final width by a set of rotary shears. Poor slitting can produce ruffled edges, wavy or crooked tape, and excessive oxide and backing debris on the recording surface.

Last, the tape may be rewound onto the final hubs, testing flanges are attached to the hubs and the finished product is packaged for sale. The boxes pass out of the factory through a massive bulk eraser that hopefully removes any residual test signals.

Errors in the manufacturing steps listed above can produce tape defects that fall into four major categories: durability, sensitivity and distortion, modulation noises, and tape-to-head contact.

Durability is virtually impossible to test without destroying the tape sample. Good results can be obtained using automatic shuttle logic connected to a recorder to 'exercise' the tape for approximately 1000 passes, but a studio can afford neither the time nor the resulting wear and tear on the studio's recorders. The only practical alternative is to be alert for any signs of oxide shedding whenever we are using a tape recorder. Any debris in the form of brown or black powder or small chunks indicates that our valuable recording is falling off the tape! High frequencies, which are recorded as short wavelengths, disappear first.

A second and even more dangerous symptom is the caking of oxide on the heads, tape lifters, or guiding components. Once the caking gets started, the residue scrapes off additional oxide due to a galling effect created by oxide rubbing against oxide. The clump of oxide soon begins to scratch the surface of the tape, destroying the high frequencies under the scratch. The only remedy for this problem is to immediately make a copy of the master before further degradation results. Losing one generation is better than losing an entire 24-track master.

Please note that the durability problems mentioned above are more frequently caused by worn or misadjusted tape transports than by bad tape. Excessive tape tension or tilted guides or lifters will produce high pressures whenever the tape touches the guides and heads. If this pressure exceed the capability of the oxide binder, the tape will begin to self destruct. Check your tape transport before contacting your tape manufacturer.

Distortion and sensitivity are directly related to the inherent magnetic characteristics of the particles used in the tape formulation. A wave analyzer, spectrum analyzer or distortion analyzer can provide a detailed analysis of the harmonic components at various flux levels. Problems with the magnetic characteristics are rare.

Noise and tape-to-head contact are the most common problems. These problems are created by errors in mixing, coating, calendering, and slitting - the areas of manufacturing which are very sensitive to processing changes. Here is where 'black art' and science overlap. Fortunately, testing of noise and tape-to-head contact are very straightforward procedures. Unfortunately, very few people appreciate both the ease and benefit of such tests.

An effective test method is to record a test signal on the tape and then monitor amplitude fluctuations during playback.

1. Rapid variations in level are caused by non-uniform dispersion of the oxide particles;

2. Occasional random bursts are due to dropouts caused by small physical defects such as dirt or voids;

3. Cyclic variations are due to fluctuating tape-to-head contact caused by poor slitting or physical deformation of the tape.

The test method for amplitude variations should be configured to avoid introducing instrumentation errors. For example, the test oscillator should be have very stable amplitude land frequency to minimize amplitude fluctuations during recording. The test frequency should be high enough to give good resolution by creating short wavelengths on the tape. The demodulator for detecting amplitude modulation should reject extraneous noise which is not due to changes in signal amplitude. An assortment of measurement bandwidths should be provided to permit the operator to discriminate among various types and sources of amplitude changes. Finally, the test technique should be standardized to permit users and manufacturers to exchange test results.

The Altair Tape and Transport Diagnostic System manufactured by Dale Manquen in Thousand Oaks, CA meets these requirements. A 12.5 kHz crystal-controlled oscillator with excellent amplitude and frequency stability serves as the stable signal source of the unit. A synchronous amplitude demodulator accurately measures the signal fluctuations in the playback signal while rejecting extraneous flutter and noise components.. Four selectable filters permit detailed study of the various AM components. LED level indicators assist the operator with setting record and playback levels to achieve repeatable results.

Introduced 20 years ago, numerous Altair systems are used by studios, tape manufacturers and recording equipment manufacturers. In addition to tape testing, the Diagnostic Systems also provide these customers with extensive flutter measurements capabilities which include not only the commonly specified weighted and.5 - 250 Hz flutter bandwidths, but also scrape flutter out to 5 kHz.

Thanks to the Altair Diagnostic System, tape testing need not be painful. A minor modification to the commonly accepted setup procedure will not only test tape, but also yield several side benefits.

Assume for a moment that you have installed an Altair unit near your console. The Altair's oscillator has been wired to a switch or patch point that momentarily substitutes the Altair's 12.5 kHz test signal for the console's tone oscillator to permit all tracks of the multitrack recorder to receive the test signal. The analyzer input of the Altair unit is patched to one of the output busses of the console so that each track can be quickly soloed for analysis. Neither of these modifications requires any major engineering effort to implement.

The setup procedure is the same as before with the addition of a 15 seconds recording of the 12.5 kHz Altair test tone. This new tone provides several short and long term benefits.

1. The Altair tone, which is derived from a crystal, is so accurate that it can be used to check tape speed at each subsequent step of the recording process. Are the overdub and mixdown recorders running at the same speed as the original tracking recorder? A simple frequency counter can be used to verify speed throughout the project.

2. The Altair tone can be used to quickly check flutter by simply activating the Flutter mode of the Altair unit.

3. Most importantly, each track of the recorder can be quickly and conveniently checked for tape quality and tape-to-head contact by merely scanning through the tracks with the SOLO buttons and checking the reading of the Diagnostic System. This yields a simple meter reading which is either above or below the accepted level of performance for your equipment. No more than two minutes of additional setup time is required since the tone is readily available.

Is this two minutes of extra time economically justified? On the positive side, consider that you are offering clients and additional 'insurance' service that gives your studio an edge on the competition. Clients prefer to work in studios that do not let them down in the middle of a session.

Does it work? A major studio utilized the Altair unit to routinely screen samples of the large batches of tape they received directly from the tape manufacturer. They were able to catch one batch of tape that had twice the normal AM content. They save themselves many headaches by catching this problem before the tape was placed in service. Not once, but twice, for the same rejected tape showed up in another shipment 6 months later, and the studio caught the defect again!

Another studio that hadn't implemented the use of their Altair unit during setup suffered a 45 minute delay in a 50 piece union scoring session due to bad tape. A postmortem of the bad roll of 2" tape revealed that the AM reading was 3 times higher that a typical good roll. This would have been easily spotted during setup.

Your cost? The Altair Diagnostic System would be inexpensive even if it only served as a tape tester, but it is an even better value since it also performs sophisticated flutter and AM analyses used for preventive maintenance and repair of recorders. The extra two minutes per setup? You figure out how many minutes of setup time equal the cost of a lost session or even a lost client, then decide for yourself if this ounce of prevention is worth a ton of regret.